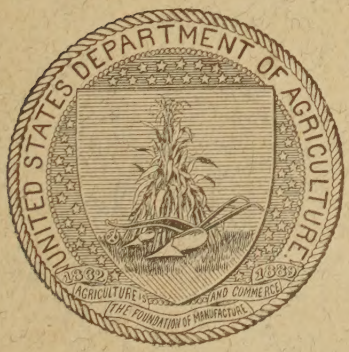
U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 119.
B. T. GALLOWAY, *Chief of Bureau.*

# THE MULBERRY AND OTHER SILKWORM FOOD PLANTS.

BY

GEORGE W. OLIVER,
PLANT PROPAGATOR, BUREAU OF PLANT INDUSTRY.

ISSUED DECEMBER 31, 1907.




COMMONWEALTH MYCOLOGICAL INSTITUTE
28 APR 1955

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

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OLD TREES OF THE WHITE MULBERRY (MORUS ALBA) IN THE GROUNDS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 119.
B. T. GALLOWAY, *Chief of Bureau.*

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# LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
*Washington, D. C., October 7, 1907.*

Sir: I have the honor to transmit herewith a manuscript entitled "The Mulberry and Other Silkworm Food Plants," by Mr. George W. Oliver, Plant Propagator of this Bureau, and recommend that it be published as Bulletin No. 119 of the Bureau series.

In 1903 Bulletin No. 34 of the series of the Bureau of Plant Industry, entitled "Silkworm Food Plants: Cultivation and Propagation," by Mr. Oliver, was prepared and issued at the request of Dr. L. O. Howard, Entomologist of the Department of Agriculture, who has charge of the investigations connected with silk culture in this country. Bulletin No. 34 has long been out of print so far as the supply of the Department of Agriculture is concerned. A new edition being called for, it was found that the electrotype plates of the publication mentioned had been destroyed, and it was therefore thought best to arrange with Mr. Oliver to prepare a new paper, bringing the information on this subject up to date. This purpose has been carried out in the manuscript now submitted.

Respectfully,

B. T. Galloway,
*Chief of Bureau.*

Hon. James Wilson,
*Secretary of Agriculture.*

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# THE MULBERRY AND OTHER SILKWORM FOOD PLANTS.

## INTRODUCTION.

The small group of trees belonging to the family Moraceæ includes those which supply the silkworm with food. There are three genera in the group: Morus, the mulberry (Pls. I to VI); Toxylon, the Osage orange (Pl. VII, fig. 1), and Broussonetia, the paper mulberry (Pl. VII, fig. 2). The last named is not true mulberry, although often mistaken for such and in some States miscalled the "white mulberry" on account of the white under surface of the leaf. It is absolutely worthless as a silkworm food plant.

The Osage orange provides excellent silkworm food only when matured leaves are used. Young succulent leaves when fed to the worms cause disease. Silk from the Osage leaves is of a very fine quality, but the young branches of this tree are thorny; this, together with the manner in which the leaves wither and pack down after gathering, makes them inferior to those of the mulberry. The young mulberry buds can be fed to the worms in the spring at a time when the Osage orange buds have not even commenced to swell.

The mulberries proper consist of several species, and of these there are numerous varieties. The white mulberry (*Morus alba*), shown in Plates I, II, and III, is most prized for feeding the silkworm; it is too tender, however, in northern latitudes with severe winters. The Russian mulberry (Pl. IV), which is a variety of the white mulberry (*M. alba* var. *tatarica*), is better adapted to cold regions. Although the leaves are smaller than in those of the white mulberry and much divided, entailing more work in feeding the worms, it is, nevertheless, considered an excellent food for silkworms. The Chinese *multicaulis*, another variety of the white mulberry, much favored for feeding purposes, is too tender in northern latitudes. Other varieties of *Morus alba* more or less used are Moretti, Downing, Rosea, and Japonica. The venosa variety of the white mulberry (Pl. VI) is used only as an ornamental plant and has no value for feeding silkworms.

The other two species commonly grown in the United States are the black and the red mulberry. The black (*Morus nigra*) is sometimes

used for feeding, but takes lower rank in this respect than *Morus alba* and its varieties. The red mulberry (*M. rubra*), the only species native to the eastern United States, is considered the most undesirable of all the mulberries as a silkworm food plant.[a]

## PROPAGATION OF THE MULBERRY.

It is intended to show in these pages how the mulberry may be propagated and grown so as to provide the maximum quantity of leaves for the supply of silkworms. The white mulberry under good cultivation is a low-growing tree, seldom attaining a greater height than 25 or 30 feet. It will reach this height in a comparatively few years after planting. Although it will live to a good old age, its growth, like that of most other trees, is most rapid when young. As the trees attain their full height they become stocky and make a multitude of small growths, from which flowers and fruit are produced. The fruit, which is usually abundant, is not a favorite in this country, being generally considered too sweet and insipid. In shape it may be said to resemble more or less that of an elongated blackberry. In the vicinity of Washington, D. C., the trees flower about the middle of May and ripen their fruit in June.

## METHODS OF REPRODUCTION.

The usual methods of propagating in use for fruit trees are employed, with varying degrees of success, in the case of the mulberry. These methods consist of budding, grafting, and layering, and the use of cuttings and seeds. Grafting and budding are by far the most expensive methods, and it is doubtful whether the results justify their use so far as raising mulberry trees is concerned. Part of the work connected with budding and grafting consists in raising stocks, which are seldom large enough for use until they are two years old. At this age the buds or grafts are inserted, and then troubles previously undreamed of present themselves to the inexperienced cultivator. Were the mulberry tree as easily managed so far as budding or grafting is concerned as are the peach and the apple, the use of these methods would be feasible; but unfortunately the mulberry is far from being an easy subject in this respect, and a few failures are apt to produce disappointment and disgust. It will frequently happen that old trees must either be removed or desirable vareties worked on them. Budding or grafting may be resorted to in such cases.

Raising young trees from cuttings of the 1-year-old ripened wood is a method which requires but little skill. As with budding and grafting, this method is instrumental in perpetuating varieties,

[a] The species known as *Morus celtidifolia* is native in the southwestern portion of this country.

as every rooted cutting will eventually be a reproduction of the tree from which it was taken. This is not the case with plants raised from seed, which always vary considerably from the parent. For this reason some mulberry growers in Europe object to the seed method. Some of the seedlings, even from a single parent tree, will vary greatly in the value of the leaves for feeding purposes. Some will be thin in texture and lacking in the necessary chemical constituents; some very hairy, while others will be thick, smooth, and in every way desirable. Experienced mulberry growers, however, can readily tell the value of a seedling tree for feeding purposes, and it is therefore possible to make a selection in this respect without much loss.

### LAYERING.

Layering may be practiced when facilities for the other methods are not at hand and when a large number of plants is not required. It consists of bending down branches of low-growing trees or suckers from the base of the trunk, cutting half way into the wood, then making a cut of about an inch upward. This cut part of the shoot is buried in the soil to the depth of 6 inches, the soil well firmed about it, and a good-sized stone put on top. If kept moist, roots will soon form. The operation of layering may be performed at any time during the spring or early summer. Those shoots which have rooted may be separated from the parent and planted at any time during the autumn or early spring. When planting the rooted layer the top of the shoot should be removed; this will induce a strong growth the following summer.

### SUMMER CUTTINGS.

Among seedling trees there will always be found individuals the leaves of which possess great adaptability for feeding purposes, such as suitable size and thickness and a less hairy surface than that ordinarily found. These should certainly be propagated to perpetuate those desirable characteristics.

Propagation should be started after the seedlings have made considerable growth, in order to insure a good supply of wood, and these plants should be increased by cuttings during the summer months. At this season it is advisable to retain some of the leaves on the cuttings and give treatment which will prevent shriveling during the process of rooting. The cuttings should be made from wood as ripe as possible. The leaves, besides being well matured, should be healthy and free from noxious insects. During July the lower parts of the current season's shoots will be found in good condition for propagating.

Trim the cuttings similarly to those shown in Plate V. At least two leaves shortened to one-half of their length should be allowed to

remain on the cutting. When placed in the propagating bed the slips should be inserted in the sand in a direction sloping from the operator. Good results will follow if a cool propagating house is used, with clean sand as the rooting medium. When a propagating house is not available a wide frame provided with sash will answer the purpose. The frame should face north, and if in the shade of trees so much the better. The sash should be kept shaded during sunshine, so that a humid atmosphere may be maintained until the cuttings take root. After they have made a considerable quantity of roots in the sand they should be transferred to beds in the open. These beds should be 5 feet wide. Place the rooted cuttings about 6 inches apart each way and water copiously until established, when they must be exposed freely to air and sunshine.

### HARD-WOOD CUTTINGS.

The principal supply of plants may be secured by propagating from cuttings, which should be made from dormant wood taken from the trees just after the leaves have fallen. In no case should the cutting wood be less in diameter than a quarter of an inch. The cuttings should be about 10 inches in length, making the upper cut about one-half inch above a bud. The position of the lower cut is immaterial. The cuttings should now be tied in bundles of 50 and either stored for the winter or immediately put out where they are to root. Where the winters are not too severe, or in the Eastern States south of the twenty-ninth parallel, they should be put in the ground during the autumn. North of this it will be found best to keep them under cover until the ground is in a condition to be worked in the early spring. If they are kept even for a short time in a dry place they will lose their sap and become shriveled; therefore, they should be buried in moderately moist sand or sand and ashes. Under such conditions a good callus will have formed around the lower cut surface before the time arrives when they are to be placed in the open ground.

If sphagnum moss can be easily procured, it may be used very successfully as a substitute for sand or ashes, but in this case the bundles of cuttings should be smaller and they should be placed with the buds pointing upward, the moss to be packed tightly around them, with the top part uncovered. This is an excellent medium for inducing the formation of a good callus.

Previous to putting the cuttings in the open the soil should be plowed deeply, then harrowed and rolled until well pulverized. A furrow is made with a spade to a sufficient depth, a little sand thrown in the bottom, and in this the lower ends of the cuttings are placed. Fill in the soil to half the depth of the furrow, firm well with the

feet, and then fill in the remainder of the soil, leaving only enough of the cutting exposed to view to keep the top bud from being covered. Where there is danger of hard freezing weather after fall planting, cover the surface with rough stable litter, this covering to be removed before the buds begin to swell during the latter part of March.

The rows of cuttings can be arranged in beds of any convenient width, leaving spaces between the beds which will facilitate covering, watering, hand weeding, and cultivating. During the summer the plants should be gone over several times and all superfluous shoots removed, leaving only one shoot to each plant. If large enough, the rooted cuttings should be removed to nursery rows the following fall. In no case should the plants be removed from the cutting beds to permanent locations. If the plants make sufficient growth the first season, they should be severely cut back; otherwise, the operation should be deferred until the following season.

The length of stem to remain as the future trunk must be regulated according to whether a dwarf or tall specimen is wanted. It must be taken into consideration that the leaves are much more easily gathered from dwarf trees than from tall ones; in fact, they are more easily managed not only so far as leaf gathering is concerned, but also in pruning and in keeping noxious insects and fungous diseases under control. The leaves on a tall tree are not all developed alike; those on the side fully exposed to the sun will naturally be in a perfect condition, while on the opposite side they are softer and probably not so well adapted to the purpose for which they are intended. Medium-sized trees are therefore preferable for all purposes.

### INDOOR SPRING CUTTINGS.

Another method of propagation from cuttings, and a very successful one, consists in selecting medium-sized shoots about the beginning of November. These, before being made into cuttings, are sorted into bundles of different lengths, tied, and heeled in ashes or sand, or in a mixture of both, and protected by a frame having a northern exposure. During the winter they are taken out and cut into lengths of about 5 inches. These are tied in bundles and buried in moist sand or moss. In early spring they are untied and inserted quite thickly in the sand of a propagating bed having a mild bottom heat, where they will root rapidly. When such a bed is lacking, wooden flats about 4 inches deep may be used for the reception of the cuttings, but they must have the protection of a frame with slight bottom heat and be covered with sash. If a little loamy soil is placed in the bottom of the flats and the remaining space filled with sand, the cuttings will remain in good condition for a considerable time after

rooting and until a favorable opportunity arrives for planting them out in nursery rows. If those rooted indoors are given plenty of air after being rooted in the bed they can be transferred during dull weather.

### PROPAGATION BY SEEDS.

Propagation by seeds is an exceedingly simple operation, and if ordinary care is given successful results will follow. Seeds sown shortly after being harvested will germinate in a few days. If kept over winter and sown in early spring the seedlings should appear in fourteen days. When the seed is spring sown, the seedlings will, if the weather be propitious, attain a height of from 12 to 18 inches in one year, but during dry seasons they will only grow from 6 to 12 inches. Seedlings from seeds sown immediately after the fruit ripens are always small at the end of the season, but they produce strong plants the season following.

The mulberry, like the strawberry, blackberry, and raspberry, does not ripen all of its fruit at one time; consequently several gatherings are necessary before a crop is harvested from any one tree. The earliest fruits can be harvested immediately after they are ripe, and the seed sown if desired. It should be remembered that seedlings thus raised have comparatively little time to make their growth; therefore, every day counts.

In gathering the fruit it will be found easiest to shake the tree and pick the fruits from the ground. To remove the seeds from the surrounding pulp, put the fruit into a large bucket or tub and squeeze with the hands until it becomes a jelly-like mass. Add water and stir well until the contents are thinned sufficiently to allow the seeds to sink to the bottom. The remaining material can be poured off. The seeds should be exposed to the air until dry. If it is desired to sprout them the same summer, they should be sown in beds in the open, the soil having been previously well worked by deep plowing and gone over several times with a harrow and roller. When the soil is sufficiently pulverized, the ground should be marked off into beds 5 feet wide and of any convenient length, leaving a space of 2 feet between the beds. To prevent washing of the soil and also to minimize the evil effects of drying winds, drive some stout stakes into the ground along the sides and ends of the beds, and to these nail 8-inch or 12-inch boards. The surface of the bed should be leveled and all stones and roots of plants removed with a hand rake.

Sow the seeds broadcast, taking care not to sow them too thick, as there is danger of the seedlings crowding each other. Crowding produces weak plants, because even the best soil is capable of supporting only a certain number of plants to the square foot. Press

the seeds into the soil with the back part of a spade and cover lightly with soil screened through a quarter-inch sieve.

In order to obtain the best results, the seed beds should not be exposed to the sun until a considerable time has elapsed after germination. This condition may be provided as follows: Procure some pieces of 2 by 3 inch scantling. Place two of the pieces parallel to each other 5½ feet apart. Nail laths from one to the other, using the 2-inch surface in which to drive the nails. Leave a 1-inch space between the laths. The slats are put lengthwise over the beds and can be used with or without the side boards. Over the slats spread archangel mats, or canvas, until germination takes place. These coverings should be frequently dampened. After the seedlings show above the ground the cloth coverings are to be kept on during the hottest part of the day only, and when the first true leaf appears they may be removed altogether and the shade necessary thereafter supplied by the lath slats. Water must be supplied if the soil needs it. With spring-sown seed the coverings over the lath slats may be dispensed with, but the surface of the bed should not be allowed to become dry until the seedlings are large enough to take care of themselves.

To raise seedlings of the Osage orange, gather the fruits as they fall from the trees and leave them out of doors until they rot. The seeds are then easily removed. Keep them in damp sand during the winter and sow in the spring, covering them 1 inch with fine soil; transplant the seedlings during the following spring.

## GRAFTING AND BUDDING.

In the silk-raising countries of Europe it is claimed that the leaves of trees raised from cuttings and seeds are superior for silk production, but that the quantity of leaves produced by trees so propagated is only about one-half the bulk of those from grafted or budded trees. Therefore, to produce a large quantity, grafting and budding methods of propagation are practiced to a great extent. This is an important point to consider, and the writer is inclined to the belief that in the propagation of plants giving the highest grades of silk there will be little danger of a scarcity of material, as in most parts of the United States the mulberry thrives as well as, if not better than, anywhere in Europe.

For those who decide to try propagating by grafting and budding two of the most successful methods of performing the operation are here described.

### ROOT GRAFTING.

Root grafting is done in February and March. The stocks, which are one or two year old seedlings of the Russian mulberry (*Morus*

*alba* var. *tatarica*), should show a diameter of at least three-eighths of an inch to give a satisfactory union. The stocks should be lifted in the fall and "heeled in" out of the reach of frost. The scions should be cut while in a dormant state and buried in damp sand in a protected place.

In the latter part of February the work of root grafting may be started. The preparatory work consists in securing a quantity of strong cotton and of grafting wax made of beeswax two parts, resin two parts, and mutton tallow one part. Put these ingredients in a small tin bucket, place on a hot stove, and when melted drop in one or more balls of the cotton, allowing them to remain in the melted wax for five minutes; remove with a pointed stick. When cool they are ready for use. Procure a deep box, in which the stocks are placed, keeping them covered with a dampened sack; another box should be provided for the scions, similarly protected, and a third one for the grafted roots. These precautions are necessary, as even a little exposure to dry air is always detrimental.

In beginning work with the stocks, sever the top from the root at the collar; this can be done best with a pair of pruning shears. The small lateral roots may be removed or shortened. Take a scion at least 5 inches long and attach by the tongue method. Select stocks and scions of as nearly the same diameter as possible and make a slanting cut at the bottom of the scion and a similar cut at the top of the stock. In the case of the scion, make an upward incision at a point about one-third of the length of the cut surface from the base; this will form a tongue. Next make a corresponding incision downward near the top of the slanting cut on the stock. The idea is to have the tongue of the scion take the place which the knife blade occupies when making the incision in the stock. When the two parts are fitted so that the bark of stock and of scion comes neatly together at one side, or at both if possible, bind firmly with the waxed cotton. This material should be used in preference to raffia, because when the grafted stock is buried in the ground raffia will be certain to rot before the union takes place, while cotton will remain in good condition for a long time.

After the fitting and tying have been done, the grafted stocks should be tied in bundles of 25, the first tie to be made rather firmly near the upper part of the scions; secure them again near the base of the scions, but not as firmly as before. Care must be taken so as not to displace the fitted parts. The bundles should now be buried in sand in a frame or other protected place until planting time arrives. The grafted stocks should be planted out just as soon as the condition of the soil will permit. Plant them so deep that only the top bud is exposed to the light.

The subsequent treatment is in all respects similar to that given for cuttings. Mark the kinds, with the dates of grafting and planting, on large labels which will not be easily displaced.

### SCION OR SPRIG BUDDING.

Scion or sprig budding is perhaps the most successful and easiest to accomplish of all methods where it is desired to perpetuate an especially good tree. It is practiced on stocks which have not been transplanted for at least one year previous to the time when it is desired to bud. The stocks should be much larger than those used for root grafting. The most desirable time for the operation is in the spring, when the bark lifts easily; this will necessarily be after the stocks come into leaf. The scions must be selected from shoots of the previous season's growth, short and stocky, with two buds present. They should be cut from the parent plants in the fall and kept dormant until the opportune moment arrives when the stock plants are in a receptive condition.

In preparing the stock for the scion the preliminary work is similar to that in shield budding the peach, cherry, or rose. At a point a little above the collar of the stock a transverse cut is made through the bark for a distance of half an inch or more around the stem. This is followed by a longitudinal cut, beginning in the middle of the first cut and extending downward for about an inch. Lift up the bark at each side of the long cut and it is ready for the scion, which is prepared for insertion by making an oblique cut through the base, so as to leave a cut surface about an inch long, and then tie the parts together so that they will be held firmly while the union is taking place. In order to exclude air and moisture, grafting wax or clay should be applied.

Within two weeks from the time of budding the union will be effected if everything has gone well. The ligature should not be removed, however, until there is danger of its cutting into the bark. The most essential part of the subsequent treatment consists in heading back the stock, so that the future head of the tree will be formed by the growth of the scion, and to do this successfully good judgment must be exercised. Cut off only a part at first, leaving some foliage on the stock until the buds on the scion begin to push, when that part of the stock above the union should be removed with a sharp knife. Cover with grafting wax the wound thus made.

### SHIELD BUDDING.

The shield system of budding may be used, but only in the spring, as the mulberry does not take kindly to shield buds inserted during the season suitable for budding most of our fruit trees.

Shield budding consists in selecting a stock, either a branch or stem, from which the bark slips readily. In raising the bark of the stock for the reception of the bud, the work is similar to that described for scion or sprig budding. The bud is usually selected from dormant wood kept over winter in ashes or sand, but for this there exists no necessity, because there is always present an abundance of dormant buds on a growing plant, and these answer the purpose much better than buds from dormant wood. To remove them, make an incision in the stem with a sharp knife about five-eighths of an inch below the bud; bring the blade up under the bud, severing a section of bark one-quarter of an inch in width, with the bud in the center. Bring the blade out a little above the bud. If this operation is neatly performed, the bud will require no further trimming before being inserted under the bark. The bark of the stock is then firmly bound over that of the bud and the parts kept in position with raffia or soft string. No waxing is necessary. The union should take place within fifteen days, after which the ligature should be loosened or removed, as proves necessary.

## RAISING STOCKS FOR GRAFTING AND BUDDING.

In grafting and budding from any particular variety which it is desired to perpetuate, the Russian mulberry (*Morus alba* var. *tatarica*) is the one used as stocks. It is of a robust-growing nature and has been found well adapted to the soils and climates of all the agricultural belts of the United States. It is this variety that is so much used in the West and Northwest for hedges, as it is the hardiest of all the mulberries.

Stocks are best raised from seeds, and a supply for this purpose should be obtained from a reliable source to avoid unnecessary delay and disappointment. The sowing and the subsequent management of the seedlings are the same with stocks as with seedlings for general planting, except that when planted in nursery rows they should be placed about a foot apart so as to give an abundance of space for the operator.

## SOIL.

So far as has been ascertained, the mulberry is not particular as to the character of the soil in which it is planted. It seemingly grows equally well in a great variety of well-drained soils. Even in sandy and gravelly situations it holds its own. In shallow soils over hardpan the mulberry thrives after most of our fruit and ornamental trees have given up the struggle. Under the same conditions the Persian mulberry has been found to fruit abundantly.

Notwithstanding its behavior under what would be supposed adverse conditions, there are few plants which respond more vigor-

ously to applications of manure than the mulberry. In Japan it has recently been shown that by liming alone the percentage of fiber in the leaves decreased very perceptibly. Again, by liming and also manuring with sodium nitrate and calcium sulphate a still further reduction in the fiber was apparent. The trees operated on were 1½ meters (5 feet) high. Each tree was treated with 500 grams (1.1 pounds) of lime, 400 grams (0.9 pound) of sodium nitrate, and 200 grams (0.44 pound) of calcium sulphate. How the caterpillars fared as a result of this change in the composition of the leaves is not stated.

## PLANTING.

The all-important operation of planting may be performed in either the fall or spring. When done in the autumn it should be attended to immediately after the leaves have fallen. In spring the trees may be transplanted at any time after the ground is in a workable condition and up to the period when the buds are about to burst into growth. Spaces intended to be planted should be deeply worked beforehand by plowing and harrowing, and after planting the weeds should be kept down.

The distance between the trees should not be less than 10 feet in the rows, and the rows should be the same distance apart. If the field devoted to the trees is more than 2 or 3 acres in extent, wider spaces should be left at intervals for wagons, etc. It is certain that trees planted 10 feet apart will eventually occupy all the space, but when there is danger of their becoming too much crowded, enough of the plants may be rooted out and burned to allow the remainder abundant space to develop. If this is done, those which are to remain permanently should be trained accordingly. The above arrangement is the best for trees, nearly all the branches of which can be reached from the ground, not only for pruning, but also for leaf gathering.

In planting trees similar precautions should be taken to those employed in the case of ordinary forest trees; that is, not to allow the roots to become in the least dry from the time they are lifted from the nursery rows until planted in the field. As soon as they are lifted the roots should be dipped in a mixture of soil and water and kept covered until planted, so that they will not become dry. If the ground is naturally hard and the soil is poor, dig large holes, even for very young trees, as they grow rapidly and should be encouraged to make good stout growths from the beginning. Put some good soil in the hole, spread out the roots on this, and cover with several inches of fine soil before firming with the feet. Allow the roots to be about the same depth in the hole as they were in the nursery rows. Prune

back the growth of young trees one-half in the fall, and, if necessary, cut back to strong buds in the early spring.

## PRUNING.

The pruning of the trees presents no special difficulties so long as it is done early enough in the season to avoid late growth, which, if caught by cold weather before ripening, will die during the winter. The principal pruning should be done in winter and should consist of shortening back strong growths so as to form a low spreading tree. Keep the central part of the tree as free of growth as possible, to admit light and air.

After the first cutting back, select three or more of the strong shoots to form the principal branches. If they are strong and show a disposition to grow upright, they may be kept apart by using three sticks tied in the shape of a triangle; place these in the center of the tree and tie the branches to them until they grow in the desired direction. By careful attention to cutting out the undesirable growths the tree can be made to assume any desired shape.

In gathering leaves always allow at least one-half of the crop to remain on the tree to insure its perfect health. Single branches should never be entirely defoliated. If some of the trees show signs of failing vigor as a result of excessive leaf gathering, it is advisable to allow them to grow for a season without picking and by the early pruning out of unnecessary growth to permit those growths which are desirable to ripen.

## FOOD FOR EARLY-HATCHED WORMS.

It sometimes happens that the eggs will hatch early in the spring before the mulberry leaves have unfolded. In such cases lettuce leaves (of the hard-leafed varieties) may be temporarily used. The oyster plant (*Tragopogon porrifolius*) may also be used for a few days. In addition to these substitutes, the mulberry leaf buds are sometimes scraped off, mashed to a fine pulp, and fed to the newly hatched worms. Where this latter course is adopted, the terminal twigs of the trees should be cut off and the buds on the pruned portions used.

# PLATES.

## DESCRIPTION OF PLATES.

PLATE I. (Frontispiece.) Old trees of the white mulberry (*Morus alba*) in the grounds of the United States Department of Agriculture.

PLATE II. Branch of the white mulberry (*Morus alba*), with large undivided leaves of thick texture and smooth surface. The leaves of this variety are preeminently adapted for silkworm food.

PLATE III. Branch of the white mulberry (*Morus alba*), with divided leaves. Seedlings from the same parent will sometimes have leaves of the divided form, others assuming the undivided shape shown in Plate II, while some may have both forms on the same tree.

PLATE IV. Branch of a seedling Russian mulberry (*Morus alba*), variety *tatarica*. This mulberry, owing to its extreme hardiness, is used for stocks on which to graft or bud the most valuable varieties in order to perpetuate their characteristics, propagation from seed being altogether unreliable for perpetuating varieties.

PLATE V. Summer cuttings of the white mulberry (*Morus alba*), with leaves shortened to prevent excessive evaporation while rooting.

PLATE VI. Branch of the white mulberry (*Morus alba*), variety *venosa*. This is an ornamental variety and is of no value as food for silkworms.

PLATE VII. The Osage orange and the paper mulberry. Fig. 1.—Leaves, fruit, and bark of the Osage orange (*Toxylon pomiferum*). Fig. 2.—The paper mulberry (*Broussonetia papyrifera*). A, leaf from old tree; B, leaf from 2-year-old seedling; C, twig with female flowers. This variety is without value as food for silkworms.

BRANCH OF THE WHITE MULBERRY (MORUS ALBA), WITH LARGE UNDIVIDED LEAVES.

BRANCH OF THE WHITE MULBERRY (MORUS ALBA), WITH DIVIDED LEAVES.

BRANCH OF SEEDLING RUSSIAN MULBERRY (MORUS ALBA), VARIETY TATARICA.

SUMMER CUTTINGS OF THE WHITE MULBERRY (MORUS ALBA), WITH LEAVES SHORTENED.

BRANCH OF THE WHITE MULBERRY (MORUS ALBA), VARIETY VENOSA.

FIG. 1.—LEAVES, FRUIT, AND BARK OF THE OSAGE ORANGE (TOXYLON POMIFERUM).

FIG. 2.—THE PAPER MULBERRY (BROUSSONETIA PAPYRIFERA).

A, Leaf from old tree; B, leaf from two-year-old seedling; C, twig with female flowers.

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